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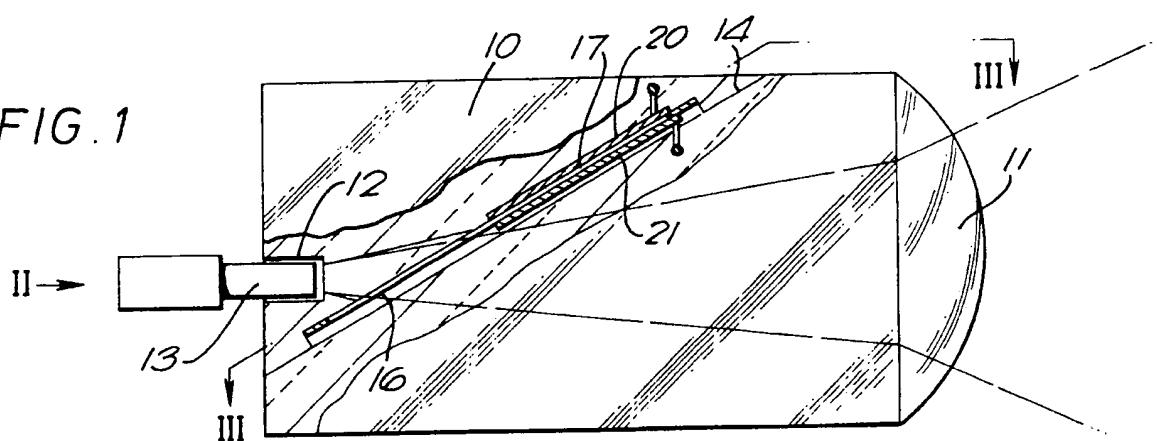
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UK CL (Edition K) G2J JGEE, G5C CHA CHH  
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## (54) Fibre optics-hydraulic shutter

(57) A hydraulic shutter comprises a block of transparent or translucent material 10 optionally having a lens 11 at one end and a hole 12 at the other end to receive an end fitting 13 of a fibre optic cable. The block is split along a line 14 and may have a gasket trapped between the two parts of the block so as to form a cavity 16 and a reservoir 17. On either side of reservoir 17 may be metal plates 20 and 21. The cavities and reservoir may contain a dielectric which may be paraffin. The dielectric may be drawn up into the reservoir 17 by charging the plates 20 and 21 so as to leave an air space in the cavity 16. While the liquid is in the cavity, the light passes unrestricted but when the liquid is drawn out of the cavity the light is totally internally reflected so that the device acts as a hydraulic switch to switch the light on and off. The hydraulic shutter may be used in a matrix of blocks forming an alpha-numeric road sign.

FIG. 1



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FIG. 1

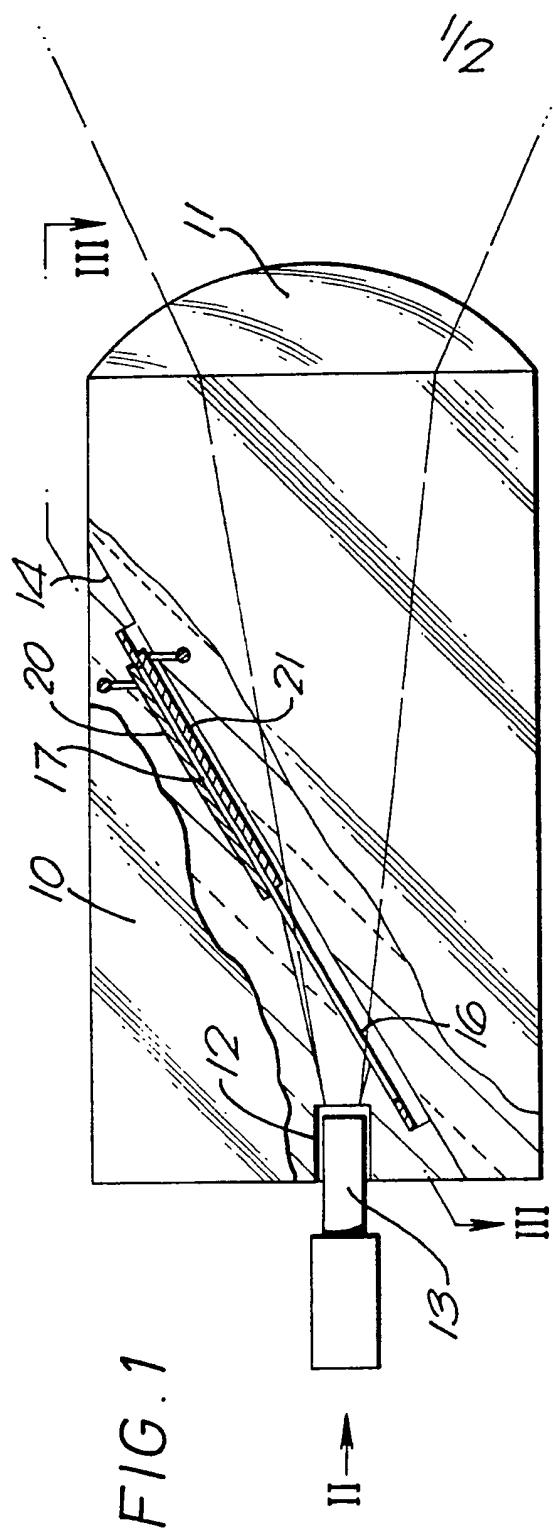
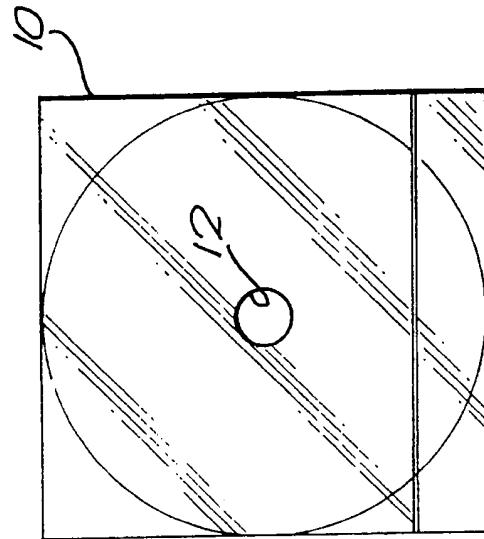


FIG. 2



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FIG. 3

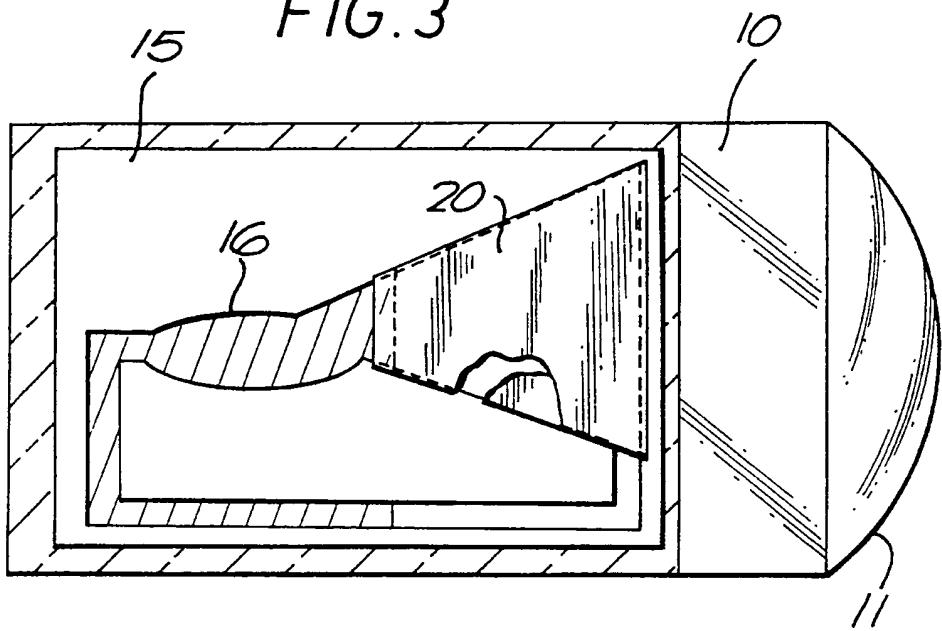
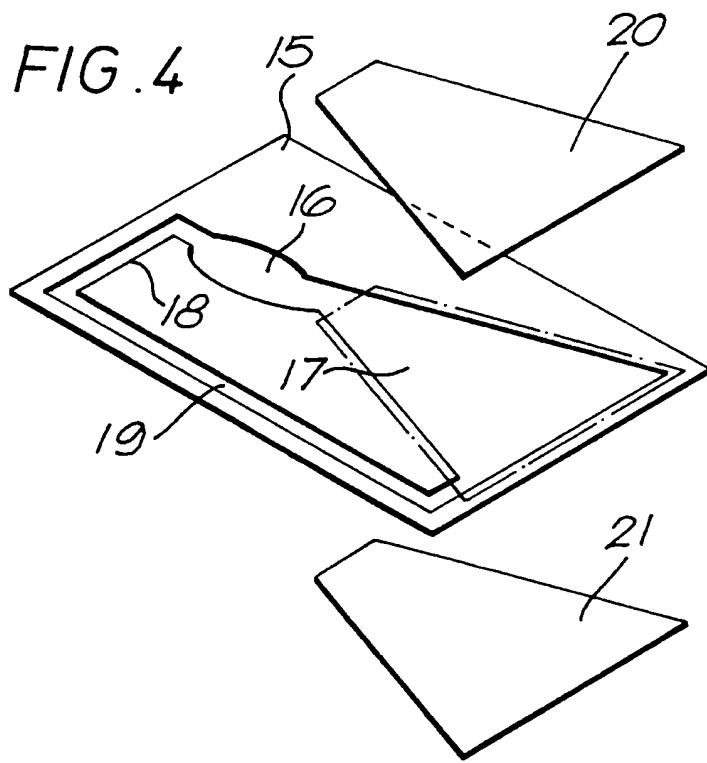


FIG. 4



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FIBRE OPTICS - HYDRAULIC SHUTTER

It is sometimes necessary to be able to close off, or shutter light from selected sources, e.g. in order to convey different messages on a signboard illuminated by optical fibres.

5 Mechanical methods have been proposed for this but these are not always reliable and, because they involve moving parts, will eventually wear out.

An object of the present invention is to provide a hydraulic shutter for light sources, such as optical fibres, which has no mechanical 10 moving parts.

In accordance with the present invention, a hydraulic shutter comprises a block of transparent or translucent material adapted to receive light from a light source, the block being provided with an internal cavity or slot into which liquid may be introduced, the 15 cavity or slot being in the path of the light from the light source, the refractive indices of the transparent material of the block and of the liquid being so selected that when the liquid is withdrawn from the light path, there is total internal reflection of the light from the light source so that the light does not pass through the 20 block and when the liquid is allowed to fill the portion of the cavity in line with the light path, the light is uninterrupted, means being provided to fill and empty said cavity of said liquid at will.

The means for moving the liquid from the cavity to the extension may be electrical, electrostatic, thermal, pneumatic or hydraulic or any combination of these means. For example, the liquid could be sucked out of the cavity through a pipe by means of a piston and 5 cylinder arrangement operable hydraulically or pneumatically.

Alternatively the liquid may be moved into and out of the cavity by forming a reservoir as an extension of the cavity, the reservoir acting as a capacitor with thin plates of metal on either side of the extension so that when the plates are charged with a voltage the 10 liquid is drawn into the space between the plates by electrostatic attraction. When the voltage is cut off, the charge on the plates quickly dies and the liquid returns to the cavity. The capacitor formed by the two plates will discharge in milliseconds thus very quickly releasing the liquid.

15 A preferred liquid for use as the dielectric is paraffin, preferably in the form known as Decane. This is a relatively safe substance, has the correct optical characteristics, is substantially impervious to leakage, and is a suitable form of dielectric for use between the metal plates forming the capacitor. The capacitor plates are 20 preferably of copper, although other metals such as stainless steel may be used.

Another alternative method of moving the liquid into and out of the cavity is to provide a pocket of air, or other gas, containing a

heater element so that when the heater element is actuated, the air or other gas will expand and drive the liquid out of the cavity, an expansion chamber being provided to receive the displaced liquid.

While the liquid is in the cavity, the light path is unrestricted.

- 5 When the liquid is drawn out of the cavity by the capacitative effect, the light is totally internally reflected.

Preferably the cavity is formed by splitting the block and placing a gasket between the two parts of the block to form the cavity.

- 10 Preferably the transparent or translucent block is made of plastics (Rtm) material such as perspex/ or it may be made of glass or any other suitable transparent or translucent material including quartz.

In choosing a liquid, it is necessary to ensure that its refractive index is as close to the refractive index of the body medium as possible to allow maximum light transmission.

- 15 It is also important that the liquid chosen shall be capable of withstanding the extremes of temperature to which the device is likely to be subjected which may be as low as -60°C and as high as 150°C.

- 20 If a gasket is used to separate the two parts of the transparent block and to form the cavity, it may be as thin as 0.4mm. The

thickness of the copper plates used to form the capacitor may be of the order of 0.2mm or less.

In order to prevent the totally reflected light from exiting from the block, the surface of the block may be painted with a black 5 coating.

In preparing the block to insert the gasket, it is preferably cut across at an angle calculated to give the best performance of total internal reflection and light transmission taking into consideration the material used for the body of the block and the liquid used.

10 One end of the block may be formed as a lens so that when the optical fibre is attached to the other end of the block, the complete assembly does not require additional parts to enable it to function.

Particularly when copper is employed to form the capacitor, it is 15 undesirable to use a liquid which could cause corrosion. Indeed, the liquid that is used should preferably include a hydroscopic additive to absorb any water which may be present.

In the accompanying drawings:-

Figure 1 is a side elevation, partly in section, of a hydraulic 20 shutter block embodying the invention;

Figure 2 is an end elevation in the direction of arrow II shown in Fig. 1;

Figure 3 is a section on line III -- III shown in Fig. 1; and Figure 4 is an exploded view of a gasket and electrodes forming 5 parts of the shutter block.

The shutter block shown in the drawings comprises a perspex block 10 with a lens 11 at one end and a socket 12 at the other end adapted to receive an end fitting 13 of an optical fibre. The lens 11 may be moulded integrally with the block. The block is split at a 10 specific angle along line 14 to receive a gasket 15 (Figs. 2 and 6).

The gasket is shaped to form an internal cavity 16, and a reservoir 17 interconnected by passages 18 and 19. On either side of reservoir 17 are thin plates of copper acting as electrodes 20 and 21 (Figs. 5 and 8). The cavity 16 is in line with the light path 15 through the block from the optical fibre to the lens. Means (not shown) are provided to apply a D.C. voltage across the electrodes 20 and 21 so as to cause liquid contained in cavity 16 to be drawn up into reservoir 17. In this condition light from the optical fibre is totally internally reflected.

20 When the voltage is cut off, the liquid will flow back into cavity 16 and the light from the optical fibre can pass through the block via cavity 16 to the lens 11.

Instead of using the electrical method described above, a supply conduit may be connected to the reservoir 17 so as to apply pressure, or vacuum, to control movement of the liquid into and out of the cavity 16.

- 5 Blocks of the kind shown may, for example, be built up into a matrix for use, for example, in illuminated alpha-numeric road signs to give warning of speed limits, hazards, etc. Such road signs are used, inter alia, on motorways.

CLAIMS

1. A hydraulic shutter comprises a block of transparent or translucent material adapted to receive light from a light source, the block being provided with an internal cavity or slot into which liquid may be introduced, the cavity or slot being in the path of light from the light source, the refractive indices of the transparent material of the block and of the liquid being so selected that when the liquid within the cavity is withdrawn, there is total internal reflection of the light from the light source so that the light does not pass through the block, and when the liquid is allowed to fill the portion of the cavity in line with the light path the light is uninterrupted, means being provided to fill and empty said cavity of said liquid at will.
2. A hydraulic shutter according to claim 1 and in which a reservoir is provided connected to said cavity and the means for moving the liquid from the cavity to the extension is electrical, electrostatic, thermal, pneumatic or hydraulic or any combination of these means.
3. A hydraulic shutter according to claim 1 in which the liquid is moved into and out of the cavity by forming a reservoir as an extension of the cavity, the reservoir acting as a capacitor with thin plates of metal on either side of the extension so that when the plates are charged with a voltage the liquid is drawn into the

space between the plates by electrostatic attraction, and when the voltage is cut off the charge on the plates quickly dies and the liquid returns to the cavity.

4. A hydraulic shutter according to claim 1 or claim 2 and in  
5 which liquid is moved into and out of the cavity by providing a  
pocket containing air, or other gas, and a heater element so that  
actuation of the heater element causes the air or gas to expand  
and drive the liquid from the cavity into a reservoir.

5. A shutter according to any preceding claim and in which the  
10 block is split and a gasket placed between two parts of the block,  
the gasket being shaped to provide the cavity, the reservoir and  
interconnecting passages for liquid flow.

6. A shutter according to any preceding claim in which the block  
(R-TM)  
is made of perspex or similar transparent plastic material, or  
15 quartz, or glass.

7. A shutter according to claim 3 in which the liquid employed  
is paraffin.

8. A shutter according to any preceding claim and in which the  
light source is an optical fibre.

20 9. A shutter according to any preceding claim in which the outer

surface of the block has an opaque covering such as a non-reflecting coating to prevent reflected light from exiting from the block.

10. An assembly of hydraulic shutters according to any preceding claim made up into a matrix to form a display and/or signalling panel.

11. A road sign comprising a matrix of hydraulic shutters according to any of claims 1 to 8.

12. A hydraulic shutter according to any preceding claim in which the liquid employed is Decane.

10 13. A hydraulic shutter according to any preceding claim in which the block has, at one end, a lens.

14. A hydraulic shutter according to claim 13 in which the lens is moulded integrally with the block.

15. A hydraulic shutter substantially as hereinbefore particularly described and as illustrated in the accompanying drawings.

16. A hydraulic shutter according to claim 1 or claim 2 and in which a supply conduit is connected to the cavity or to the reservoir to apply a gaseous pressure, or vacuum, to fill and empty said cavity.

**Amendments to the claims have been filed as follows**

1. An assembly of hydraulic shutters made up into a matrix to form a display and/or signalling panel in which each shutter comprises a block of transparent or translucent material adapted to receive light from a light source, the block being provided with an internal cavity or slot into which liquid may be introduced, the cavity or slot being in the path of light from the light source, the refractive indices of the transparent material of the block and of the liquid being so selected that when the liquid within the cavity is withdrawn, there is total internal reflection of the light from the light source so that the light does not pass through the block, and when the liquid is allowed to fill the portion of the cavity in line with the light path the light is uninterrupted, means being provided to fill and empty said cavity of said liquid at will.
- 10 2. An assembly according to claim 1 and in which a reservoir is provided connected to said cavity and the means for moving the liquid from the cavity to the extension is electrical, electrostatic, thermal, pneumatic or hydraulic or any combination of these means.
- 15 3. An assembly according to claim 1 in which the liquid is moved into and out of the cavity by forming a reservoir as an extension of the cavity, the reservoir acting as a capacitor with thin plates of metal on either side of the extension so that when the plates are charged with a voltage the liquid is drawn into the space between the plates by electrostatic attraction, and when the voltage is cut off the charge on the plates quickly dies and the liquid returns to the cavity.
- 20
- 25

4. An assembly according to claim 1 or claim 2 and in which liquid is moved into and out of the cavity by providing a pocket containing air, or other gas, and a heater element so that actuation of the heater element causes the air or gas to expand and drive the liquid from the cavity into a reservoir.
5. An assembly according to any preceding claim and in which the block is split and a gasket placed between two parts of the block, the gasket being shaped to provide the cavity, the reservoir and interconnecting passages for liquid flow.
- 10 6. An assembly according to any preceding claim in which the block is made of perspex or similar transparent plastic material, or quartz, or glass.
7. An assembly according to claim 3 in which the liquid employed is paraffin.
- 15 8. An assembly according to any preceding claim and in which the light source is an optical fibre.
9. An assembly according to any preceding claim in which the outer surface of the block has an opaque covering such as a non-reflecting coating to prevent reflected light from exiting from the block.
- 20 10. A road sign comprising an assembly of hydraulic shutters according to any of claims 1 to 9.
11. An assembly according to any preceding claim in which the liquid employed is Decane.

12. An assembly according to any preceding claim in which the block has, at one end, a lens.
13. An assembly according to claim 12 in which the lens is moulded integrally with the block.
- 5 14. A road sign incorporating a hydraulic shutter substantially as hereinbefore particularly described and as illustrated in the accompanying drawings.
15. An assembly according to claim 1 or claim 2 and in which a supply conduit is connected to the cavity or to the reservoir to
- 10 apply a gaseous pressure, or vacuum, to fill and empty said cavity.

Patents Act 1977

Examiner's report to the Comptroller under  
Section 17 (The Search Report)

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Relevant Technical fields

(i) UK CI (Edition K ) G2J (JGEE) ; G5C (CHA, CHH)

(ii) Int CI (Edition 5 ) G02B, G09F

Search Examiner

C J ROSS

Databases (see over)

(i) UK Patent Office

(ii)

Date of Search

1 JULY 1991

Documents considered relevant following a search in respect of claims

1-16

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB A 2204710 (GEC)	1 at least
X	EP A1 0306604 (SIEMENS)	"
X	EP A1 0158551 (THOMSON)	"
X	EP A1 0136193 (THOMSON)	"
X	EP A1 0042907 (IBM)	"
X	US 4121884 (ISEC)	"

Category	Identity of document and relevant passages	Relevant to claim(s)

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E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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